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ABSTRACT

The Analytical Review Project, conducted by UCLA's Center for the Study of Evaluation under the auspices of the U.S. Office of Education, evaluated 20 major longitudinal studies of the impact of schools and colleges on students' cognitive, personal, and vocational development. This project included a critical appraisal of the methodology used in each study as well as the studies' findings. The convergence and divergence of findings are reported together with underlying methodological problems and recommended methodological procedures for survey research particularly as they pertain to enhanced understanding of the relationship between student development and the educational process. The major recommendation is that research should go beyond merely identifying causal or predictive relationships, which is the current orientation, to explicating causal or predictive relationships with analyses that tell why a specific relationship exists (interpretation) and what conditions maximize and minimize the strength of the relationship (specification). (Author/KM)

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THE USE OF EXPLICATIVE ANALYSIS IN EDUCATIONAL RESEARCH

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Introduction

The Analytical Review Project, sponsored by the National Center for Educational Statistics of the U. S. Office of Education was designed to analyze several major longitudinal studies in order to discover variables, techniques, methodologies and problems pertinent to evaluative studies of the impact of schools and colleges upon the growth and development of young adults. The results of this analysis are reported in five volumes cited in the addendum to this paper. Volume I contains the theoretical framework of the project, together with highlights of the substantive and methodological issues raised by the studies selected for analysis. Volume II contains the dynamics of the abstracting process utilized in the project, the typology of the variables used in the research, an overview of the major issues suggested by the research and comprehensive summaries or abstracts of each of the studies reviewed. Volume III presents the logic of survey research, the major data collection technique used in the studies, problems

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common to survey research, impact analysis including the problem of measuring change, and a critical analysis of the research designs, methodologies and techniques used in the studies reviewed. In addition, a checklist of recommended guidelines for educational research included which serves concomitantly as a means by which survey research studies may be evaluated and also as a beginning collection of evaluative criteria. The synthesis and implications of the findings including matrices of the findings and variables derived from the studies under review comprise Volume IV. Volume V consists of a "users guide" or reference index to the other four volumes, summary of the technical aspects of the research studies and a classification of the instruments used in the studies. This paper focuses upon one of the major issues treated in Volume III; the use of explicative analysis in educational research.

Explicative Analysis

Almost without exception the search for causal relationships has become the primary concern of educational researchers. Although a causal analysis may indicate that a relationship probably exists, it does not necessarily identify the reason why a particular variable produces certain effects. Thus the researcher may determine that small classrooms contribute to higher verbal achievement scores, yet be uncertain as to the underlying processes responsible for this relationship. Explicative studies attempt to answer this type of research question. The key word in explicative analysis is

elaboration. Explicative studies are designed to test specific hypotheses and thereby to elaborate the relationships between variables, including the processes, precipitating factors or events, and the structural contexts which mediate the relationships. Explicative analysis is therefore the logical extension of causal analysis. Once a causal relationship has been detected, the researcher should attempt to explicate this relationship by identifying factors which will interpret the relationship and specify the conditions that will make it more or less probable. Interpretation and specification analysis should therefore be an integral part of the overall data analysis strategy of the educational researcher.* The extent to which observed relationships were statistically interpreted and specified in the Analytical Review studies is assessed in the following section.

Interpretation Analysis

The contribution of a study is enhanced considerably when the analyst can identify the reasons why a particular relationship exists. This is especially true in educational research where knowledge of the underlying processes responsible for a relationship is necessary before sound policy decisions can be made. Statistical interpretation attempts to identify and clarify these underlying processes by introducing additional test factors into the analysis.

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*For excellent discussions of specification and interpretation analysis, see, Paul F. Lazarsfeld and Morris Rosenberg, The Language of Social Research. New York: The Free Press, 1955, Section II, pp. 115-125; Herbert H. Hyman, Survey Design and Analysis. New York: The Free Press, 1955, Ch. 7, pp. 275-327; Morris Rosenberg, The Logic of Survey Analysis. New York: Basic Books, Inc., 1968; and C. Y. Glock (ed.), Survey Research in the Social Sciences. New York: Russell Sage Foundation, 1967.

To perform interpretation analysis upon a two variable relationship the researcher statistically controls or reduces the effects of an interpretation test factor--a third variable that intervenes in temporal sequence between the independent and dependent variable. When successful interpretation occurs, the original relationship is sharply reduced or disappears when the effects of the interpretation test factor are statistically controlled.

Although interpretation analysis can make important substantive contributions to educational research, the Analytical Review indicates that analysts were not systematically testing interpretation hypotheses. The studies reviewed did contain attempts at statistical interpretation, but for the most part they remain isolated attempts lacking the necessary integration with causal analysis to become a viable research strategy for understanding the dynamics of human growth and development.

Examples of interpretation analysis can be found in Coleman (1966), Shaycoft (1967) and Bachman (1970). Coleman found that minority students attending integrated schools scored higher on achievement tests than did minority students attending segregated schools even when the effects of social class were statistically reduced. This important finding merited further investigation to determine why integrated schools had this effect.

Several plausible interpretations were advanced to explain this observation. Minority students might have achieved higher scores in integrated schools because predominately White schools have better physical facilities, higher quality teaching

staffs or more remedial courses. Differences with the peer environments of integrated and segregated schools could also have accounted for the greater achievement of minority students in integrated schools. The peer group in integrated schools compared to segregated schools may have encouraged and rewarded academic excellence to a much greater extent thereby motivating the minority students to perform better scholastically.

To determine which of these competing hypotheses was most credible, Coleman performed an interpretation analysis which has become a classic example of this testing procedure in educational research and clearly illustrates that important information can be obtained by systematically searching for interpretation variables. The results of Coleman's analysis revealed that it was the influence of the peer group, rather than the impact of the physical resources of the school or the quality of the teaching staff, which accounted for the relationship between school integration and academic achievement. In the words of Coleman:

> The higher achievement of all racial and ethnic groups in schools with greater proportions of white students is not accounted for by better facilities and curriculum in their schools. . . . The higher achievement of all racial and ethnic groups in schools with greater proportions of white students is largely, perhaps wholly, related to effects associated with the student body's educational background and aspirations (p. 307).

Thus, when the differential effects of various school resources were statistically controlled, the observed differences in the academic achievement of minority students attending integrated and segregated schools remained. However, when the effects of the educational aspirations and achievements of the

student body were statistically reduced, the differences which had previously existed in the educational achievements of these students disappeared. This is strong evidence in support of the interpretation that minority students tend to perform better in integrated schools because of the differential characteristics of the student subculture. Furthermore, as Coleman notes:

> This means that the apparent beneficial effect of a student body with a high proportion of white students comes not from racial composition per se, but from the better educational background and higher educational aspirations that are, on the average found among white students (p. 307).

Shaycoft provides several notable illustrations of interpretation analysis in her report of Project TALENT data. Shaycoft was interested in identifying the magnitude of the direct effect that socio-economic status had on grade twelve achievement. Consequently, the analysis of the influence of social class upon twelfth grade achievement was repeated after the effects of student aptitude, grade nine achievement, courses in high school and college plans were statistically controlled. According to Shaycoft:

> After the effects of their various causative (or <u>possibly</u> causative) factors . . . have been eliminated from the socio-economic variable statistically, the part correlations of the residuals with grade 12 test scores are negligible (1967, pp. 8-24).

Although this test was conceptualized as an attempt to estimate the direct causal relationship between social class and academic achievement, it also serves as an example of interpretation analysis. The results of this investigation indicated that the original relationship between socio-economic

class and academic achievement was due, in large part, to the mediating influence of those variables that were statistically controlled in the analysis.

Bachman's analysis of the racial differences in the responses to a job ambitions index illustrates a systematic attempt to identify an interpretation variable. Bachman found that the scores of Black students, regardless of whether they attended integrated or segregated schools, were lower than Whites on a scale presumed to be measuring the job ambitions of the student. In search of an interpretation, Bachman adjusted the scores on the basis of seven background characteristics and scores to the Ammons Quick Test of Intelligence. Although the racial differences did diminish in this phase of the analysis, the basic relationship remained; Blacks had lower job ambitions than Whites.

The ambitious job attitudes index was composed of two major dimensions; attitudes toward jobs "that pay off," and attitudes toward jobs "that don't bug me." Bachman surmized that a separate analysis of these two components of the original scale might reveal the reason for the racial differences in the scores. Consequently, the analysis was repeated using these two dimensions as separate criterion variables. According to Bachman, the results of this investigation were definitive:

> There are scarcely any racial differences in preferences for "a job that pays off" . . . racial differences do appear when we consider preferences for "a job that doesn't bug me." Along this dimension we find integrated blacks more than one-third standard deviation higher than whites; for northern segregated blacks the difference exceeds one-half

> standard deviation, and for southern segregated blacks the difference reaches three-quarters of a standard deviation (1970, p. 147).

Thus, the Black students in this sample were as equally ambitious as Whites for "jobs that paid off." However, the Black students were less tolerant than Whites of "jobs that bug me." This led Bachman to conclude that:

> The young black high school student probably knows better than most whites what it means to have "a job that <u>does</u> bug me," and avoiding that sort of job seems more important to him than to the average white. In our view, it is likely that some of the items on the "job that doesn't bug me" scale mean something very special to black respondents, and that this, more than anything else, accounts for the racial differences we have observed her (1970, p. 147).

As previously noted, there are not many examples of interpretation analysis in the Analytical Review studies. In some cases this was due to the lack of data. In many cases, however, the analyst failed to perform an interpretation analysis when the necessary data were available. The work of Trent and Medsker (1968), Astin and Panos (1969), Lehmann and Dressel (1963), and Hilton (1971) are cases in point.

Trent and Medsker observed that socio-economic class was moderately associated with college persistence in the expected direction; the higher the social class standing of the student the greater the probability of persisting in college. In addition, academic achievement in high school and the amount of income earned from part time employment during college were also predictive of college persistence. College students who had low academic achievement in high school or worked part-time for over half of their income were more likely to withdraw

from school than students who had high academic achievement in high school or did not work for over half of their annual income. Since data regarding two principal interpretation variables were available for each analysis--the academic achievement of the student and his employment--Trent and Medsker may have been able to determine why lower class students withdrew from college at a greater rate than upper and middle class students. Unfortunately, however, an interpretation analysis was not performed and as a result it is uncertain whether lower class students withdrew from college because they had lower academic ability or because they were employed.

Astin and Panos missed several opportunities to statistically interpret observed relationships. For example, they discuss their observations of environmental effects by type of institution (pp. 141-145) and the effects of specific environmental characteristics (pp. 145-147) under separate headings in their report and never attempt to integrate these two groups of findings through a systematic strategy of interpretation analysis. Instead, the researchers speculated that:

> . . . some of the environmental effects observed in particular "types" of institutions may be wholly or in part a consequence of differences among the institutions in some of the (environmental) characteristics described below (p. 145).

The "may be wholly or in part a consequence of" clause, however, represents an empirical question which could have been tested with the data that were available for analysis.

Thus, Astin and Panos report that universities and liberal arts colleges had very different dropout rates. Attrition at the liberal arts colleges was substantially lower than

would be expected on the basis of student input characteristics. In contrast, the dropout rate at the university was greater than would be expected. The researchers also report that colleges with cohesive peer environments had much lower dropout rates than were predicted from student input characteristics while colleges with fragmented peer environments showed the reverse pattern. These relationships suggest that liberal arts colleges have lower dropout rates than universities because their peer environments are more cohesive. Clearly, this is a plausible interpretation that should have been tested. Unfortunately, the investigators failed to do so. Instead, Astin and Panos postulated the following alternative explanation:

> Although there are many possible explanations for the sharp contrast between liberal arts colleges and universities, one interesting hypothesis is suggested by the fact that these two groups of institutions differ markedly with respect to two environmental factors, Familiarity With The Instructor and Concern For The Individual Student. Perhaps the university professor, who spends relatively little time with his students and much time in pursuing his own scholarly interests, provides a relatively poor role model in comparison with the college teacher, who often takes a more personal interest in his students (p. 142).

Even here, the investigators failed to test their interpretation. They could have statistically controlled for the items "Familiarity With The Instructor" and "Concern For The Individual Student" to determine if these two variables did, in fact, interpret the relationship in question. Since they failed to perform this test, their interpretation remains an unconfirmed speculation.

Lehmann and Dressel (1962) also missed an opportunity to clarify the underlying processes of a major relationship reported in their study of Michigan State students. They found that religion was highly associated with a student's value orientation and dogmatism score. The apparent influence of the student's religious training was manifest in two related observations. First, Catholic students were more stereotypic and dogmatic than Protestants or Jews and were also more traditional-value orientated. Jewish students, on the other hand, were more emergent in their value orientation than either Catholics or Protestants. Secondly, students who had previously attended public high schools were less dogmatic, stereotypic and more likely to be emergent in their value orientation than students who had attended parochial schools.

The researchers also report that students' social class was associated with their value orientations and dogmatism scores. Students whose parents had a high level of education were less stereotypic, dogmatic and had more emergent value orientations than students whose parents had little formal education. In addition, students whose fathers had a high occupational rank were more emergent in their value orientations, less stereotypic and dogmatic than students whose fathers had a low occupational rank.

Social class can often statistically interpret relationships between religious affiliation and various criterion variables. In this case, social class might have interpreted the relationship between religious affiliation and critical thinking, values, and attitudes. Thus, Lehmann and Dressel

could have determined whether the effect of the student's religious background upon his value orientation and attitudes was due primarily to the influence of social class, or the more direct effects of religious training. Although a simple test of interpretation would have clarified this issue, the analysis was not performed and important information was lost.

Evans and Patrick (1971) conducted an analysis of high school dropouts from data derived from Hilton's study. In this investigation the analysts observed the expected relationship between the age of the student in the fifth grade, his scores on various SCAT and STEP tests, and withdrawal from high school. Fifth grade students who were later to drop out of high school tended to be approximately one year older than their classmates and obtain scores on achievement and ability tests which were significantly lower than those students who continued through the eleventh grade.

Certainly a critical question to ask at this point is <u>why</u> the older students in the fifth grade had a much greater probability of withdrawing from high school than the younger students. Age and achievement scores were both highly correlated with the criterion variable. In addition, the achievement scores only explained about one percent of the variance in the dependent variable after the age of the student was introduced into the correlation equation. This suggests substantial scores. Thus, it seems plausible that the academic achievement of the student could serve as an interpretation test factor accounting for the relationship between age and withdrawal from high school. In other words, on the basis of the

existing data it could be argued that the students who were older in the fifth grade were less capable of performing well in high school and consequently were more likely to become frustrated, disillusioned and finally to drop out of school altogether.

Evans and Patrick, however, appear uncertain of the underlying process responsible for the association between student age in the fifth grade and high school persistence:

> Dropouts are nearly a year older in fifth grade than their non-dropout peers. The dropouts may have failed one or more grades or may have started school later than their peers. . . . Another possible explanation is that grade retention acted to cause dropping out, rather than simply predicting that a student would eventually drop out of school. The important finding is that the age discrepancy is apparent as early as the fifth grade (p. 131).

Although the relationship between student age and withdrawal from high school was an important finding, it is also important to determine why age is a crucial factor in predicting the criterion variable. Interpretation analysis could have answered this question.

Educational researchers in general have been negligent in conceptualizing, measuring and testing interpretation variables. As a result, the systematic use of statistical interpretation has not been rigorously pursued in educational research. This is indeed unfortunate because the results of interpretation analysis can be tremendously enlightening to the researcher as well as to the educational policy-maker.

Specification Analysis

Specification analysis is another form of statistical

elaboration which can be performed on a bivariate relationship. Testing for specification, like interpretation analysis, involves statistically controlling the effects of a third variable. Unlike tests for interpretation, however, successful specification analysis does not result in the disappearance of the original relationship. Rather, the original relationship is strengthened or weakened, or the direction of the relationship is changed in the partial relationships. Thus, successful specification analysis identifies a third variable (i.e., a specification test factor) that statistically interacts with the original relationship by specifying the conditions which make the original relationship more or less probable.

There are no time constraints on specification test factors. They can be antecedent, posterior, or simultaneous with the independent or dependent variables in temporal sequence. In addition, successful specification analysis can frequently stimulate further elaboration. Thus, when specification has been observed, the analyst will usually ask why the original relationship was found to be conditional. This, in turn, could lead to an interpretation analysis.

The results of systematic specification analysis can provide information that is of equal if not greater value than that obtained from an interpretation analysis. For example, in order to achieve optimal allocation of school resources in terms of maximum impact upon the student population, it is necessary to determine which students will receive the greatest benefit from exposure to a particular school resource. The search for specification test factors will often identify variables that

strengthen or weaken the association between a school characteristic and a particular educational outcome. Frequently, these factors are student background variables. Thus, specification analysis can provide the investigator with valuable information concerning the differential impact that certain school characteristics have upon different student subgroups.

Coleman's study illustrates the importance of specification analysis in educational research. Coleman found that the student's academic achievement was only marginally affected by differences between schools. However, after a specification analysis was performed in which comparisons were made between racial and ethnic groups, important interschool differences emerged. In general, the variation in academic performance that existed between schools was noticeably larger for minority students than for majority students. This finding suggested that the academic performance of minority students was more sensitive to the impact of different school environments than was the academic achievement of majority students. As Coleman writes:

> Indirect evidence suggests that school factors make more difference in achievement for minority group members than for whites; for Negroes, this is especially true in the south. This result suggests that insofar as variations in school factors are related to variations in achievement, they make the most difference for children of minority groups (p. 297).

Coleman then continued this analysis by introducing data which indicated that the academic achievement of minority students was, in fact, more sensitive to the impact of various school characteristics. For example, the magnitude of per-pupil expenditures, the quality of the teaching staff, and

numerous characteristics of the school facility, including the size of the school and the presence of laboratories, extracurricular activities and guidance programs were found to have a larger impact upon the academic performance of minority students than majority students. Thus, Coleman uncovered an important specification test factor that strengthened the association between various educational experiences and academic achievement.

In a similar fashion, Astin and Panos tested for specification in their analysis of the quality of undergraduate institutions and the student's intellectual achievement. The researchers state the major hypotheses of their investigation in the following manner:

> Stated in positive terms, the general hypotheses tested in this analysis were as follows;
>
> 1. The academic excellence of the undergraduate institution - as defined by the level of ability of the student body, the level of the institution's financial resources, and the degree of academic competitiveness in the college environment - has a positive effect on the undergraduate student s intellectual achievement.
> 2. The extent of the positive effect of institutional quality on intellectual achievement is proportional to the student's academic ability (1969, p. 72).

The second hypothesis incorporates a test for specification. That is, Astin and Panos propose that the effects of institutional quality will statistically interact with the student's academic ability to produce a higher association between the quality of the educational institution and the student's intellectual achievement when the student has high academic ability.

The results of this analysis, however, provided little support for either hypothesis. The academic excellence of the school was not strongly or consistently associated with academic achievement after the effects of student background characteristics were statistically controlled. Furthermore, the academic ability of the student did not significantly influence the strength of the association between the quality of the school and the student's academic performance.

Of course, the value of specification analysis is not restricted to policy-orientated research. The results of systematic specification analysis can make an equally important contribution to the development of learning and socialization theory, as illustrated by the work of Kagan and Moss (1962). In their longitudinal study of psychological development, Kagan and Moss consistently tested for specification by comparing the similarity of behavioral patterns between different time periods for both males and females. Many of their findings strongly support the hypothesis that early sex role identification has important implications for adult behavior. For example, Kagan and Moss report that a passive, in contrast to a retaliatory reaction to frustration, was highly stable for boys and girls during the first ten years of life. However, early passivity in males was essentially unrelated to adult behavior while it was moderately related for females. According to Kagan and Moss:

> The primary reason for this lack of continuity in males is the development of conflict over passive and dependent behavior. A passive orientation to problems is inappropriate for the male role. . . . This conflict, which does not swell to such strong

> proportions in middle class girls, leads to minimal continuity between childhood and adult dependency for males (1962, p. 58).

Thus, by focusing upon sex as a specification test factor, Kagan and Moss were able to contribute valuable information supporting the notion that differential cultural expectations for dependency and passivity in males and females will influence the pattern of psychological growth and development.

Bachman (1970) also performed specification analysis in his panel study of adolescent boys. He originally found that majority and minority students attending integrated schools had similar self-concepts of school ability, while Blacks in segregated schools had somewhat lower self-concepts. However, the relationship was dramatically reversed when the scores were adjusted for a number of student background characteristics including social class and general intelligence. There was a pronounced tendency for Blacks attending either segregated or integrated schools to have relatively higher self-concepts of school ability than Whites. Furthermore, this same basic pattern was repeated for self-esteem. Southern segregated Blacks had self-esteem scores that were similar to Whites, but after controlling for background characteristics and general intelligence, their adjusted scores were higher than Whites. According to Bachman:

> It is frequently assumed that Black Americans, as a result of centuries of slavery and discrimination, have lower self-esteem than whites. This may be true of adults, but our data lead us to question this assumption as applied to young men in high school. . . . Our view is that the fairly high self-esteem scores for Black respondents represent a real feeling of self-worth (1970, p. 199).

The theoretical contribution of Bachman's analysis was enhanced by systematically testing for specification. The results of this analysis not only uncovered an important relationship that was suppressed in the original analysis, but it provided valuable information concerning the possible changes in self-concept that may be occurring among minority students today.

Despite its obvious value, researchers have not systematically and uniformly introduced specification test factors into their analyses. Astin and Panos, for example, report that colleges which have a relatively large percentage of students who work for pay have considerably higher dropout rates that were predicted from student input data. The researchers also had extensive information on the college environment; measures of the cohesiveness and competitiveness (vs. cooperativeness) of the peer environment, various indicators of the classroom environment such as student involvement in the class and severity of grading practices, data on the administrative and physical environment of the school, student's subjective impressions of the college environment, the instructor's concern for the student, flexibility of the curriculum, and the degree of academic competitiveness.

Valuable information could have been obtained if Astin and Panos had determined if these environmental factors specified the relationship between student employment and college persistence. High school guidance counselors, for example, could use this information to advise students who anticipate working during college that they would have a greater probability of graduating from particular types of schools (e.g., those

characterized by low academic competitiveness, liberal grading practices, or a cohesive peer environments). Unfortunately, tests were not conducted using environmental data as possible specification test factors.

The study by Trent and Medsker provides a number of similar illustrations. The researchers report, for example, that two-year college transfers had a statistically higher rate of attrition than native students. A considerable amount of data on student background, family, and school environmental variables were available for analysis. Consequently, Trent and Medsker were in a position to identify situations or experiences that would increase the likelihood of transfer students persisting in college. The researchers, however, did not specify or interpret this relationship, and again valuable information was lost.

The dearth of systematic specification analysis is evident in Project SCOPE. Tillery and associates (1972) report that in a subsample of students drawn from California, Illinois, Massachusetts and North Carolina, minority students (excluding Oriental Americans) tended to have lower educational aspirations than White students. The researchers did not attempt to elaborate this relationship, however, by performing an additional analysis designed to identify specific educational experiences that contributed to the lower aspirations of minority students.

In addition, the data from this subsample indicated that junior colleges attract a similar number of students scoring at all four levels of an intellectual predisposition (IPD) test

consisting of items from the Thinking Introversion, Theoretical Orientation, and Autonomy scales of the Omnibus Personality Inventory (Center for the Study of Higher Education, 1962). It would have enhanced the contribution of this analysis if the researchers had identified the factors that increased the probability of a student with a high intellectual predisposition enrolling in a junior college. Again, although the data were available an important test for specification was not conducted.

Opportunities to perform specification analysis were also missed in Project TALENT. Flanagan et. al. (1962), for example report that the size of the senior class and the average class size were not highly associated with high school achievement (correlated below .20 with school achievement). No attempt was made to identify student background variables or other school characteristics that would increase or weaken the magnitude of these relationships. Consequently, no information was provided concerning the type of student who would benefit most from exposure to small classrooms.

As a final example, Thistlethwaite (1965) reports that the student's disposition to seek advanced training was:

> . . . strengthened by association with peers having high educational aspirations, favorable teacher evaluations of college performance, winning social recognition for intellectual achievement, participation in Honors Programs and graduate-level courses, and by undergraduate participation in research programs and projects (1965, pp. 91-92).

The above relationships indicate the direct or independent impact of these college experiences upon the criterion

variable as determined by a multiple regression analysis. However, these findings pertain to students in general and not to particular subgroups of students. That is, Thistlethwaite determined that there was a tendency for all students to seek advanced training if their peer groups had high academic aspirations or their teachers evaluated their academic performance favorably. Consequently, although Thistlethwaite reports that these college experiences "strengthened" the student's disposition to seek advanced training, he did not perform a true specification analysis.

While it is important to ascertain the independent effects that college experiences have upon the student's desire to seek graduate training, it is also important to determine which students will benefit most from exposure to these experiences. In other words, what factors strengthen or weaken the association between participating in honors programs or receiving a favorable teacher evaluation and student disposition to seek graduate training? These questions are truly representative of the types of questions asked in a specification analysis. Thistlethwaite did not attempt to answer these questions in his investigation.

Educational researchers in general, and the Analytical Review investigators in particular, have not systematically tested for specification or interpretation. Instead, they seem preoccupied with developing prediction equations that link a number of independent variables to a specific dependent or criterion variable.

While it is generally recognized by theoreticians and methodologists alike that the ability to accurately predict a specific educational outcome will yield valuable insights into the dynamics of the phenomenon in question, it is nonetheless important to remember that these causal or predictive relationships are not the only or necessarily even the most significant source of information.

The most valuable scientific contributions are those which not only identify causal or predictive relationships but also explicate these relationships by analyzing additional variables that are not conceptualized as independent variables but as elaborating test factors. The discovery of a causal relationship does not signify the end of systematic inquiry, but the beginning. It is critically important to the advancement of educational research and to the development of enlightened policy recommendations that analysts introduce and subsequently test hypotheses which identify (1) the reasons why a specific relationship exists (interpretation) and (2) the conditions that maximize and minimize the strength of the relationship (specification). A serious effort should therefore be made to supplement the current orientation of simply predicting specific educational outcomes with one that emphasizes the need to explicate predictive or causal relationships with interpretation and specification analysis.

Accordingly, it is recommended by the Analytical Review staff that:

> Investigators should be required to develop a conceptual model that identifies specific variables to be used as interpretation and

specification test factors. In addition, each major hypothesis of the investigation should be outlined and discussed in terms of which variables will be used to interpret and specify the expected results.

ADDENDUM

An Analytical Review of Longitudinal and Related Studies as they apply to the Educational Process.

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